

## REMARKS

The Examiner has newly rejected Claims 1 - 4 and 18 - 20 under 35 U.S.C. § 103(a) as being unpatentable over the combination of Dillon et al. (Surface Science 322(1995) 230-242) and Penneck et al. (4,985,313). Applicant respectfully submits that the combination of Dillon and Penneck does not teach or suggest *inter alia* deposition of  $\text{Al}_2\text{O}_3$  on a substrate by a cyclical sequential vapor deposition process in which the substrate is exposed to trimethyl aluminum (TMA) and atomic oxygen in a single reaction chamber.

The process disclosed in Dillon for the deposition of aluminum oxide does not teach or suggest using atomic oxygen as the oxygen source, as recited in independent Claims 1 and 18. Instead, every embodiment mentioned in Dillon relies on water vapor to grow  $\text{Al}_2\text{O}_3$ . The use of water vapor to grow the  $\text{Al}_2\text{O}_3$  film does not in any way teach or suggest using atomic oxygen in the aluminum oxide deposition process.

The Examiner found that while Dillon does not teach use of atomic oxygen as the oxygen source, this deficiency was made up for by Penneck. However, Penneck teaches moving a substrate, on which a metal layer has previously been deposited, through oxygen plasma in a separate chamber to form a coating of metal oxide. Claims 1 and 18 were amended previously to clarify that the sequential chemical vapor deposition processes, including exposure of the substrate to TMA and atomic oxygen, takes place within a ***single reaction chamber***. Penneck does not teach or suggest this feature.

The process disclosed in Penneck and cited by the Examiner (column 11, lines 1 - 18) is directed to the oxidation of a complete, previously deposited aluminum layer. That is, the aluminum layer is deposited to a desired thickness in one chamber, and then subsequently oxidized in a plasma oxidation unit. There is no suggestion that the plasma should be supplied in the same reaction chamber in which the aluminum is deposited.

Moreover, the process disclosed in Dillon comprises a plurality of cycles in which  $\text{Al}_2\text{O}_3$  is deposited. That is, thin layers of  $\text{Al}_2\text{O}_3$  are deposited in multiple cycles. In the process in Penneck, all of the aluminum is deposited first, after which the layer is oxidized. There is no indication in the art that Penneck's use of atomic oxygen could or should be carried out cyclically. Nor is there any indication in the art that Penneck's use of atomic oxygen would be desirable or useful in the process of Dillon, where only monolayers of aluminum precursor are to be oxidized rather than the considerably thicker aluminum layer being oxidized by Pennek.

Penneck is also directed to forming aluminum oxide on cables, and thus would not have the same concerns as Dillon, which is directed to atomically thin films for applications such as “high dielectric insulators” on silicon surfaces. Because of the significant difference in the processes and results described in the references, one of skill in the art would not combine the teachings of Penneck with Dillon in a manner that meets the claims without a reason for doing so. Neither of the asserted references provide any such reason. There is simply no teaching or suggestion in the references nor the art generally to use atomic oxygen in a cyclical process like that of Dillon to deposit aluminum oxide on a substrate in a single reaction chamber.

Further, Claim 1 explicitly indicates that in each cycle, “more than one monolayer of  $\text{Al}_2\text{O}_3$  is formed.” In contrast, Dillon teaches a true atomic layer deposition process in which no more than one monolayer is deposited per cycle. Dillon states that “[i]n the simplest form of atomic layer processing (ALP), the adsorption is self-regulating and *a full or partial monolayer of an element is deposited per operational cycle....*” (Page 230, column 1; emphasis added). The Examiner found Dillon at pages 239 et seq. to teach variation in the thickness per cycle of the aluminum oxide layer. However, the section of Dillon cited by the Examiner is directed towards the per-cycle efficiency of coverage of the deposited atomic layer of aluminum oxide and not towards its thickness. As such, Dillon teaches variation in the thickness of the layer only *up to* a full atomic monolayer; Dillon does not teach or suggest a thickness greater than one full atomic monolayer. There is no teaching or suggestion in Dillon (or Penneck) to deposit more than one monolayer of  $\text{Al}_2\text{O}_3$  per cycle. Indeed, Dillon explicitly teaches that the adsorption mechanism upon which the deposition technique is based is *self-regulating* so that Dillon does not even recognize the possibility of depositing more than a monolayer per cycle.

With respect to dependent Claims 4 and 20, Dillon teaches away from methods of depositing an  $\text{Al}_2\text{O}_3$  film at room temperature. In the abstract, Dillon states that “optimal conditions for  $\text{Al}_2\text{O}_3$  growth were observed using TMA and  $\text{H}_2\text{O}$  exposures at 0.3 Torr on substrates *at 500K*” (emphasis added). On page 238, Dillon states “spectral results reveal that the TMA reaction with a hydroxylated alumina surface *does not go to completion at 300K*” (emphasis added). Dillon then goes on to discuss the superior results at 500K. The higher temperatures preferred in Dillon (in comparison to room temperature) indicate a difference in the processes that cannot be explained away by routine experimentation and would not be obvious to one of ordinary skill in the art. Room temperature deposition did not provide a complete atomic

monolayer in the process of Dillon. Thus, neither Dillon nor the combination of Dillon with Penneck teaches or suggests methods of depositing aluminum oxide film at room temperature.

The remaining dependent claims also teach further distinguishing features of particular utility, but are not separately addressed as moot in view of the patentability of Claims 1 and 18, as discussed above.

In view of the remarks presented herein, Applicants respectfully submit that the pending claims are not obvious in view of the combination of Dillon and Penneck and request withdrawal of the rejections under 35 U.S.C. § 103(a) and allowance of the pending claims.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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